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PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Improvements in Drilling Devices

We, BRAUNKOHLEN- U. BRIKETTWERKE RODDERGRUBE AKTIENGESELLSCHAFT, a German Company, of Brühl, Bez. Köln, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us and the method by which it is to be performed to be particularly described in and by the following statement:—

The invention relates to drilling devices which are operated by compressed air or compressed gas and are employed especially for deep drilling. It is known so to construct and to use such a device that it is introduced into the drill hole and functions so drive the drilling tool by striking or beating it down immediately in front of the base of the drill hole.

The invention has for its object to provide drilling devices of this kind, which are adapted to perform the most difficult drilling operations and can be operated with high pressures. An aim is to provide such devices which can work with great air power and also overcome a high exhaust counterpressure in that they can still give substantial impact power even deep below a column of water or mud in the drill hole. A further object of the invention is to construct a drilling device of the kind referred to as simply as possible and in such a way as to make it insensitive to soiling. The supply of compressed air or compressed gas may be effected through a hollow rod or through a high-pressure hose which is let into the drill hole along with a carrying rope. On the other hand, it is also possible when employing a hollow rod for the supply of compressed air or compressed gas to simultaneously use this rod for changing the position of the drilling tool or for rotatably driving it in the usual way.

According to this invention there is provided a drilling device, especially for deep drilling, which is operated by compressed air or compressed gas (pressure medium) and is adapted to be introduced into the drill hole, the said device comprising a cylinder within which is arranged to reciprocate a stepped impact piston so formed as to provide an annular space between the inner surface of the cylinder and the body of said piston, and the device being characterised in that the surface of the impact piston on which the pressure medium is effective in the direction of the impact stroke is at all times in free communication with the supply of such medium, and in that the return stroke of the piston is produced by a predetermined and controlled quantity of the pressure medium admitted into the aforesaid annular space.

The supply of pressure medium to the piston is preferably effected through a hollow piston rod which is guided within a central bore in the impact piston.

This central bore is advantageously made in such a manner that it is brought into communication with the annular space of the impact piston through openings which are uncovered by the piston rod at the end of the impact stroke. According to the invention, it is, furthermore advantageous for the exhaust of the pressure medium to take place at the end of the return stroke and at the beginning of the impact stroke, preferably during the same distance of travel of the piston on the return stroke and impact stroke For this purpose, the cylinder is preferably provided, in the region of an upper part of the return stroke, with a widening which is in communication with the exhaust.

Owing to a controlling device constructed in this way, there is available for the exhaust in the case of the device according to the invention a comparatively long time which renders it possible to use very high pressures for the pressure medium; this is extremely important for the practical working of drill holes which are under drilling mud and for overcoming very high counter-pressures of exhaust. It is known to be much more difficult, in the case of structurally limited cross-sections, to lead the released exhaust air out of a pneumatic hammer than to pass in highly compressed air.

[Price 3s. 6d.]

These difficulties become still greater in the case of counter-pressure working. It is therefore necessary to increase considerably the time that is available for the exhaust. According to the invention, this is achieved by releasing the exhaust during the last part of the return stroke and the first part of the impact stroke and not during or at the end of the impact stroke, as is usual in the case of pneumatic hammers.

On the whole, in the case of a drilling device according to the invention, the control is effected by the pressure medium which freshly enters the cylinder, first accelerating the impact stroke of the piston, which is descending owing to its own weight, and, at the end of the impact stroke, passing into the annular space between the stepped piston and the cylinder and being caused to expand there, in order to effect the return stroke. Only at the end of the return stroke and during the same distance of travel of the piston for the impact stroke, is the exhaust of the air effected for a great interval of time, which, in the case of devices operating with mud-drilling, is controlled as to its openings into the drill hole, advantageously by shutting-off members which are constructed in the manner of check valves.

Further advantageous details of the invention are to be seen from the accompanying drawings, in which the invention is further explained with reference to two constructional examples thereof.

In the drawings,

Figure 1 is a longitudinal section of a drilling device, according to the invention, at the end of the impact stroke;

Figures 2 and 3 are a graphic comparison of the invention with known pneumatic hammers; and

Figure 4 is a longitudinal section of another form of the improved drilling device shortly before impact.

In the example of the invention shown in Figure 1, 1 denotes a long, thin cylinder in the form of a casing tube having a length of from 4 to 8 metres or more, in which is arranged a heavy impact piston 2 which is shorter, in its stroke, by about 1 to 2 metres. The impact piston 2 has, at its upper end, a stepped extension 3 which is guided, in a sealed manner, against the inside of the wall of the cylinder 1 with a labyrinth throttle packing or one or more piston rings made of synthetic plastic. Near its lower end, the impact piston 2 is preferably provided with three of four guiding bosses 4 which may, for example, be constituted by steel balls inserted in depressions in the impact piston 2. The annular space between the cylinder 1 and the impact piston 2 is denoted by 5. The provision of this space is an important factor upon which the operation of the hammer depends and is, in fact, an essential feature of the invention. Owing to the double guiding of the long impact piston 2 by the stepped extension 3 and the guiding bosses 4, the said piston is unaffected by an elastic bending of the long cylinder 1 in a bore hole that is not straight; this is of special importance, since, in this way, jamming is obviated. The volumetric size of the space 5 is of decisive importance to the satisfactory operation of the hammer.

The cylinder 1 is closed, at its top end, by a plug 15 having therein a central bore in which is secured a hollow piston rod 6 which latter, on the upward and downward movement of the impact piston 2, is accommodated within a central bore 16 formed in the impact piston 2. Fresh air is fed into the drilling device through the bore of the hollow piston rod 6. Fixed in the inner bore 16, which may be in the simple form of a roughly drilled blind hole, directly beneath the stepped extension 3, are two packing rings or collars 7 and 8, between which there are apertures 9 which connect the bore 16 with the annular space 5. The piston rod 6 is constantly surrounded by the upper ring or collar 7, whilst it slides out of the lower ring or collar 8 a few centimetres before the impact piston strikes the inner spigot-like end 10 of the drilling tool 11. The drilling tool 11 may be in the form of an impact inner tube or a bit and be connected, through its inner end 10, with the cylinder 1, advantageously through a drag coupling 17.

The cylinder 1 is provided with an exhaust widening 12 at its top end, and, located on the side wall of the plug 15, is the exhaust valve 13 which may, for example, be in the form of a rubber collar surrounding exhaust openings 19.

The operation of the tool represented in Figure 1 will now be described beginning from the end of the impact stroke.

Shortly before the impact piston 2 strikes the inner end 10, highly compressed air passes from the piston rod 6 into the annular space 5 which has a capacity of several litres. The filling of the annular chamber 5 with highly compressed air is terminated when, on the upward stroke of the impact piston 2, the ring 8 again surrounds and closes the piston rod 6. The highly compressed air in the annular space 5 expands and, by its pressure on the bottom surface of the impact piston 2 and the annular surface of the stepped extension 3, drives the impact piston 2 upwards, overcoming its own weight and the force which results from the pressure of the fresh air and the outer cross-sectional area of the piston rod 6. Since the inner bore of the piston rod 6 is at all times in free communication with the supply of compressed air, no additional compression of the compressed air takes place in the bore 16. As soon as the stepped extension 3 of the piston 2 reaches the exhaust widening 12 at the top end of the cylinder 1, the air can escape from the annular space 5 and be exhausted through the check valve 13 into the drill hole. However,

owing to its kinetic energy, the impact piston 2 rises to a considerably higher level and releases the compressed air from the annular space 5, through the widening 12 and, further, through the path to the exhaust valve 13. This path to the exhaust is closed only when the piston 2 has travelled through the same distance from its top dead point and the stepped extension 3 leaves the widening 12 downwards and thus closes the annular space 5. The piston now drops owing to its own weight in the direction of the impact stroke, the latter being accelerated by the compressed air acting in the middle bore 16. At the end of the impact stroke, the operation described is repeated.

In the graphic representation (Figures 2 and 3), the invention is compared with a pneumatic tool of the kind hitherto usual. Figure 2 illustrates the time-distance curve of a known self-controlling stepped-piston hammer and Figure 3 is a similar representation of a hammer according to the invention with the same impact number. On the ordinate *a* of the representation, the stroke of the piston has been recorded, and, on the abscissa *b* the time of the piston stroke has been recorded. The bottom dead point of the piston has been denoted by *c* and the top dead point of the piston has been denoted by *d*. The distance t_e denotes the duration of the exhaust and t denotes the duration of a complete operation. In both cases, the impact piston strikes hard at the bottom dead point *c*, so that a sharp reversal of the curve takes place. The piston does not strike at the top dead point. It therefore retards its movement parabolically to zero (top dead point) and again accelerates from there parabolically. The course of the time-distance curve is therefore rounded at the top dead point. For a definite distance of travel, more time is therefore necessary at the top dead point than at the bottom dead point. In the case of the tools hitherto known, the exhaust takes place at the end of the impact stroke and at the beginning of the return stroke. Consequently, the time available for this purpose, denoted in the graphic representation by the distance t_e, is relatively small (Figure 2). In contradistinction, in the case of the device according to the invention illustrated by Figure 3, the exhaust takes place at the end of the return stroke and at the beginning of the impact stroke. Since, in this region, the time-distance curve has a rounded course, there is also available for the exhaust, in the case of the invention, a much greater time t_e than in the case of the known tool according to Figure 2; that is to say, in the case of the invention, with cross-sections structurally limited in the same way, a very much greater quantity of air can be discharged by the exhaust owing to the longer time that is available.

In the case of the known self-controlling stepped piston, the return stroke is effected under the action of the existing pressure in the annular space. At the end of the return stroke, the admitted air flows into the working space of a definite size and, on expanding, drives the impact piston in the impact stroke, the oppositely acting pressure of the annular space being overcome. Such a known stepped piston is, therefore, in the direction of the return stroke, uninterruptedly under the action of the force of the annular space. In contradistinction the impact piston according to the invention is, precisely in the opposite direction, namely in the direction of the impact stroke, uninterruptedly under the action of the piston force of the feeding rod 6. (The diameter of the piston rod 6 is an important factor).

However, the controlling arrangement according to the invention is not merely the reversal of the known principle of the stepped piston. The stepped piston must, for example, at the two offsets, be accurately tightened to the casing, for which reason long piston strokes render necessary long, accurately machined bores in the casing. In the case of the arrangement according to the invention, only a short upper part of the piston is tightened to the casing. Consequently, there may be employed, as the cylinder, an entirely unmachined, drawn tube which may be as long as desired.

The construction of drill hammers, which are as long and as powerful as desired, is, for the first time, rendered possible by the arrangement according to the invention. Owing to the long annular space 5 between the piston rod and the casing, the hammer is insensitive not only to elastic strain but also to internal soiling.

However, the arrangement according to the invention is also specially suitable for powerful hammers with an average and also with an extremely high impact number. Especially in the case of the latter is there fully obtained the advantage of the comparatively long period of exhaust owing to the exhaust in the back part of the return stroke.

In Figure 4 there is illustrated, by way of further example, a rapidly striking hammer constructed in accordance with the invention. In this case, the piston rod 6 is provided, at its lower end, with labyrinth grooves or similar packings and has a stepped extension 18 on which these labyrinth grooves are arranged. This stepped extension 18 controls the perforations 9 in the central bore 16 of the impact piston 2.

On operating such a rapidly striking hammer with a long supply hose, another and small auxiliary bore 14 is provided in order to ensure the starting. In the case of a slow increase of pressure in the hose, the piston rises slowly only to such an extent that the perforations in the piston 2 are covered by the piston rod (position shown).

A small additional exhaust is opened by in this piston rod the auxiliary bore 14. Consequently, the piston performs small swinging

movements about the closing position, which increase with increasing pressure in the bore and thus effect the starting.

An important feature of the self-control according to the invention is, therefore, that with the drilling device in use, the impact piston is at all times subject, in addition to its weight and gravity, to the action of a pneumatic force in the direction of impact, whilst the return stroke is produced by the force of an expanding predetermined quantity of air. In addition, very high pressures may be employed. The control and form of hammer according to the invention can also advantageously be employed for pneumatic percussion tools for general use, for example for rammers, chisel hammers, etc. It is specially well suited for being fitted in a very small construction immediately behind the drilling chisels in the case of combined rotating and percussive drills, the so-called vibro-drills, not least for the reason that the casing need only be thin, and great power can be accommodated in a very small space. The control can also be employed with advantage in the case of rotationally operating piston pneumatic machines with a crank drive.

WHAT WE CLAIM IS:—

1. A drilling device, especially for deep drilling, which is operated by compressed air or compressed gas (pressure medium) and is adapted to be introduced into the drill hole, the said device comprising a cylinder within which is arranged to reciprocate a stepped impact piston so formed as to provide an annular space between the inner surface of the cylinder and the body of the said piston, and the device being characterised in that the surface of the impact piston on which the pressure medium is effective in the direction of the impact stroke is at all times in free communication with the supply of such medium, and in that the return stroke of the piston is produced by a predetermined and controlled quantity of the pressure medium admitted into the aforesaid annular space.

2. A device according to Claim 1, wherein pressure medium is supplied to the impact piston through a hollow piston rod which is guided within a central bore in the said piston.

3. A device according to Claim 2, wherein the central bore in the impact piston is in communication with the annular space between the cylinder wall and the body of said piston through apertures which are uncovered by the piston rod at the end of the impact stroke.

4. A device according to any of the preceding claims, wherein the exhaust of the pressure medium is effected at the end of the return stroke and at the beginning of the impact stroke.

5. A device according to Claim 4, wherein the exhaust takes place during the last part of the return stroke and the first part of the impact stroke through the same distances of travel of the piston.

6. A device according to any of the preceding claims, wherein the cylinder is, in the region of the return stroke, provided with a widening which is in communication with the exhaust.

7. A device according to any of the preceding claims, wherein the exhaust is, towards the drill hole, controlled by shutting-off members constructed in the manner of check valves.

8. A device according to any of the preceding claims, wherein the impact piston is guided in the cylinder, its top end, by its stepped extension and, beneath it, preferably near its bottom end, by special supports.

9. A device according to any of the preceding claims, wherein the packing of the central piston rod in the upper part to the impact piston is effected by means of two grooved ring collars, the bottom (front) one of which, shortly before the impact, slides out above the end of the piston rod and thus frees the supply of air for the return stroke through perforations between the two collars, whilst the upper (back) collar constantly surrounds the piston rod.

10. A device according to any of Claims 1 to 8, wherein the central piston rod is guided tightly in the bore of the impact piston or is provided with labyrinth chambers, and the impact piston is provided with an additional auxiliary outlet bore or a passage which frees the auxiliary exhaust precisely when inlet perforations in the impact piston are covered by the piston rod.

11. A drilling device constructed substantially as hereinbefore described with reference to and as illustrated by Figures 1 to 3 of the accompanying drawings.

12. A drilling device constructed substantially as hereinbefore described with reference to and as illustrated by Figure 4 of the accompanying drawings.

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1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

Fig. 1

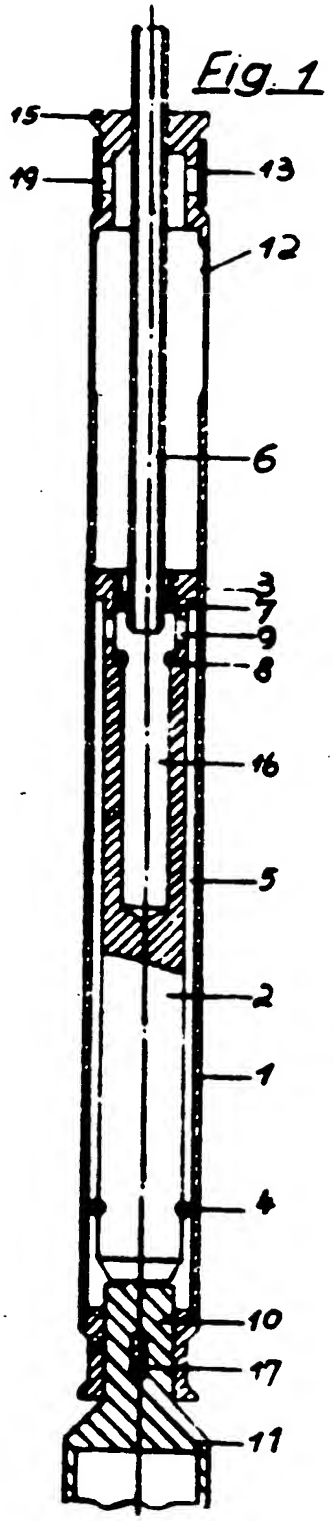


Fig. 2

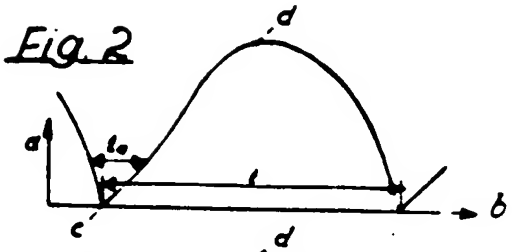
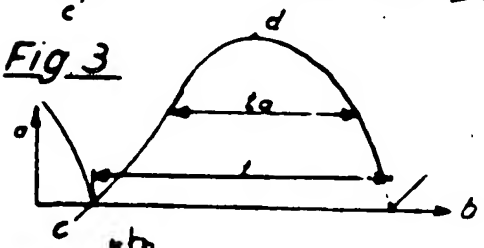


Fig. 3



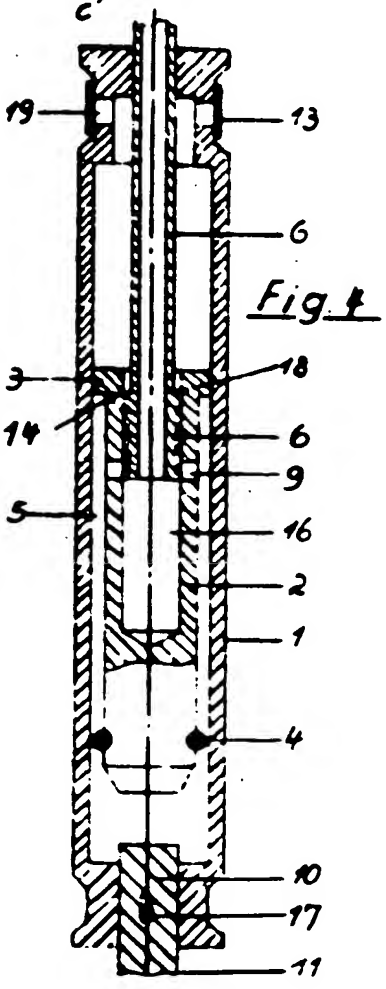


Fig. 4

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